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Production Engineering Measure on High Perveance Cathode-Ray Tubes

SEVENTH QUARTERLY PROGRESS REPORT

This report covers the period:
9 December 1962 to 8 March 1963

Contract Number DA 36-039 SC-85965
Order Number 6020-PP-61-81-81

U. S. Army Electronics Materiel Agency
Industrial Preparedness Directorate
Philadelphia, Pennsylvania

PICKUP TUBE OPERATION
POWER TUBE DEPARTMENT
GENERAL ELECTRIC
Syracuse, N. Y.

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Object of Study: To develop a low drive (high perveance) cathode-ray tube incorporating electron guns of Focus Reflex Modulation design.

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I. ABSTRACT

This is the seventh quarterly report describing the progress of the production engineering measure on high perveance cathode-ray tubes for the period 9 December 1962 to 8 March 1963. During this quarter, engineering sample tubes were started, as required by the contract.

II. PURPOSE

The Focus Reflex Modulation (FRM) principle in electron-gun design has demonstrated a capacity for low-level modulation that makes the concept useful for transistorized display equipment. The FRM development program has been based on theoretical electron-optics work and laboratory-produced models. The techniques used in the manufacture of these models have been very exacting so that correspondence between theory and measured results could be achieved. This has required precisely machined parts incorporating designs based on complex mathematical relationships.

Manufacturing methods for the current developmental models are considerably different from those used in a relatively high-volume cathode-ray tube production facility. A review of the FRM structure from the manufacturing standpoint needs to be made, particularly in terms of part shapes, stamping techniques, alignment requirements, and gun assembly techniques.

The focus reflex electron-gun designs also have to be adapted for use in military cathode-ray tube envelopes and in accordance with military specifications.

The logical steps toward providing manufacturing capability of focus reflex modulation cathode-ray tubes would be as follows:

1. Establish tube designs that would be suitable for quantity production and would meet Signal Corps specifications.

II. PURPOSE (Continued)

2. Establish a limited manufacturing facility capable of producing two-hundred-total focus reflex modulation tubes per month on a single-shift basis. The cathode-ray tubes to be produced are divided into two representative types. The General Electric Company development tube number Z4808 has been assigned to the twelve-inch round faceplate cathode-ray tube that is to meet the requirements of Signal Corps specification SCS-105. The other type is a five-inch diameter faceplate cathode-ray tube, which has been assigned the General Electric Company development number Z4809 and which is to meet Signal Corps specification SCS-106.
3. Train unskilled or semiskilled direct labor operators to perform the process work.
4. Test the productivity and quality control with a pilot run.

A program such as this was begun with the awarding of Signal Corps Contract DA 36-039 SC-85965 to the General Electric Company. The progress of this program during the seventh three-month period is described in the following sections.

III. ENGINEERING SAMPLE TUBES

After the conclusion of the design phase of this contract in the previous quarter, work was begun on the construction of engineering samples and preproduction tooling.

The problems encountered in the design-sample phase were limited to the spiral-lens construction. The development tubes used to prove out the lens design required oversized neck tubing to accommodate the large spiral-lens glass attached to the electron gun. The adoption of standard 1-7/16" neck tubing and the consequent reduction required in electron-gun outside diameter was the first problem area encountered.

The necessary smaller gun diameter required tooling of a mechanism that would paint the graphite spiral on the inside of the anode barrel. Prior to constructing this spiral-paint machine, several experiments were conducted, using a vacuum deposition of nichrome to form the resistive spiral. Spirals constructed in this manner were unstable in value; therefore, although this method shows promise as a high-volume production technique, more developmental work would be required.

In view of the limited time remaining on the contract, the nichrome-spiral technique was abandoned; and construction of a graphite-spiral paint machine was begun. A search for suitable graphite paints was undertaken. After some experimentation, a graphite-paint mix that would give the proper range of resistance was found. This mix could be applied easily by production workers.

III. ENGINEERING SAMPLE TUBES (Continued)

Processing of the sample tubes was started by the first week in March. (Figure 1 shows the FRM gun assembly for these tubes.) Typical test data on these engineering samples are shown in Figure 2 (Z4808) and Figure 3 (Z4809). The testing voltage arrangement used is shown in Figure 4. Operation of the focus-electrode circuit in this manner produced a smooth focusing action with approximately one-half milliampere current flowing through the focus-electrode circuit. The average transconductance of the samples measured 46 micromhos, as compared with 20 micromhos for a conventional cathode-ray tube.

This quarter's work has produced a uniform testing procedure for evaluating these devices and a preliminary set of production drawings.

FOCUS REFLEX MODULATION GUN ASSEMBLY

WITH SPIRAL FOCUS LENS ELECTRODE

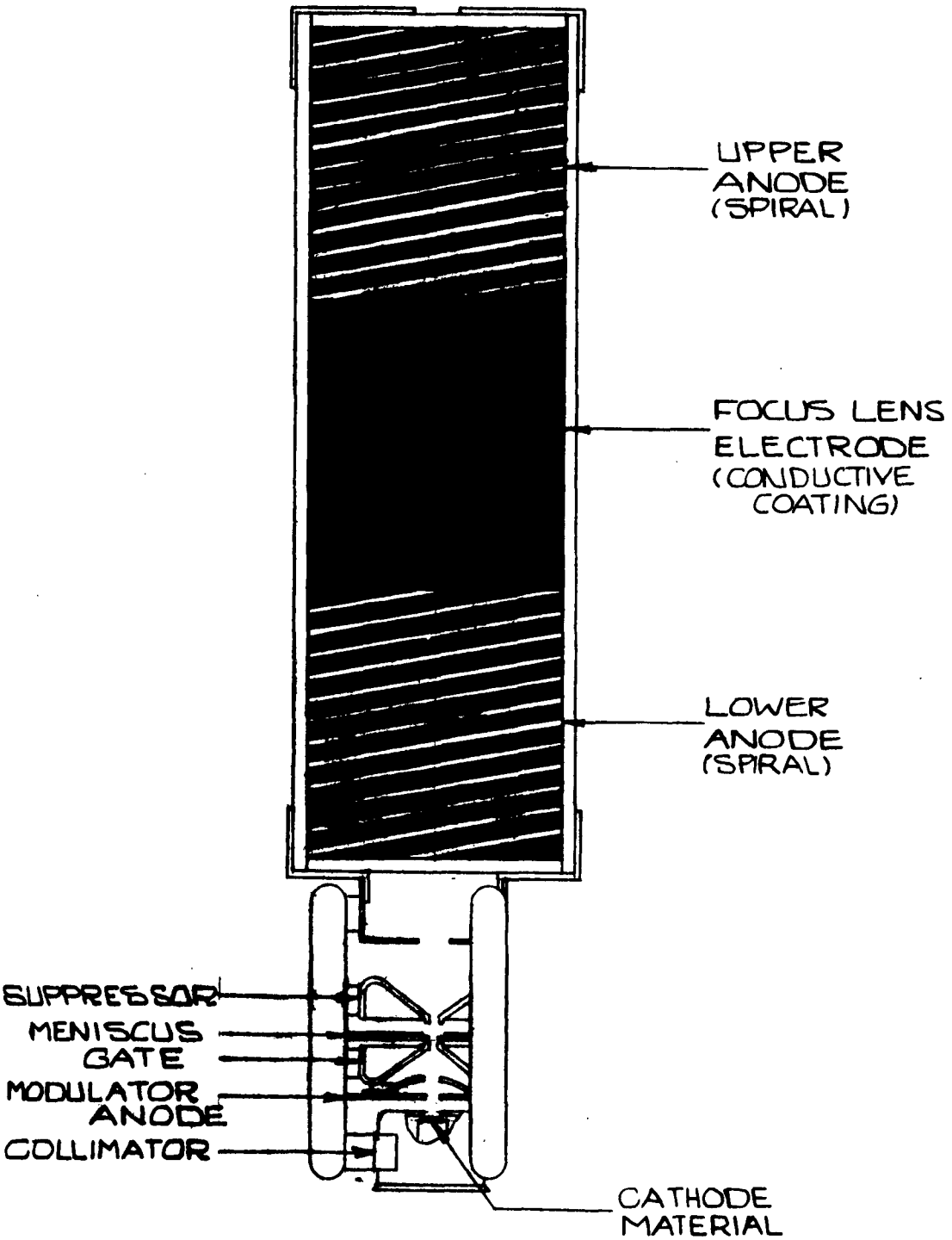


FIGURE 1

FIGURE 2-A

GENERAL ELECTRIC COMPANY

Focus Reflex Modulation Magnetic Deflection Tube Type Z4808
Tested By RATE
Part I: ELECTRICAL TESTS - Per Specification MIL-E-1 **Date** 26 FEB 63

Test Conditions: E_f 6.3 E_c ADJ E_{b2} 7000 E_a 500 E_s 455

Breakdown: E_{b2} 10000

REF.	TEST	UNITS	Serial No. # 105		# 106		# 107		# 108	
4.6.1	Preheating		—		—		—		—	
4.10.8	Heater Cur.	Amps	.57		.58		.58		.58	
4.12.1.1	Anode #1 Cur	μAdc	550		400		550		600	
4.12.1.2	H-K Breakdown		OK		OK		OK		OK	
4.12.1.4	Voltage Bkdn.		OK		OK		OK		OK	
4.12.2.2	Gas Ratio									
4.12.4.2	Stray Emis. (Std)		NONE		NONE		NONE		NONE	
4.12.5.1	Blemish		OK		OK		OK		OK	
4.12.5.3	Modulation Vdc 750 μA		17		25		18.5		17.5	
4.12.5.4	Screen(P-7) cd5		—		—		—		—	
	G5:1		—		—		—		—	
4.12.5.4.1	Scr. Brightness cbf		—		—		—		—	
4.12.6.2	Line width A at 100μAdc		.015		.018		.012		.012	
4.12.7.1	Spot position mm		10		14		15		15	
	Zero-bias anode cur	μAdc	900		760		1000		900	
	GateCutoff (1)Ibs=5 amp.	Vdc	-23		-26		-24		-23	
	Gate Raster Cutoff	Vdc	-29		-34		-30		-30	
	Gate Spot Cutoff	Vdc	-70		-70		-68		-65	
	Focus volt at 100μA:	Vdc	+1380		+1500		+1360		+1400	
4.12.4.1	Cathode Illumination		OK		OK		OK		OK	
4.12.13.1	Heater-cath 1kg	μAdc	0		0		0		0	
	Aperture align.	%	—		—		—		—	
	Gate leakage:	μAdc	0		0		0		0	
	COLLIMATOR :	Vdc	+20		+10		+20		+20	

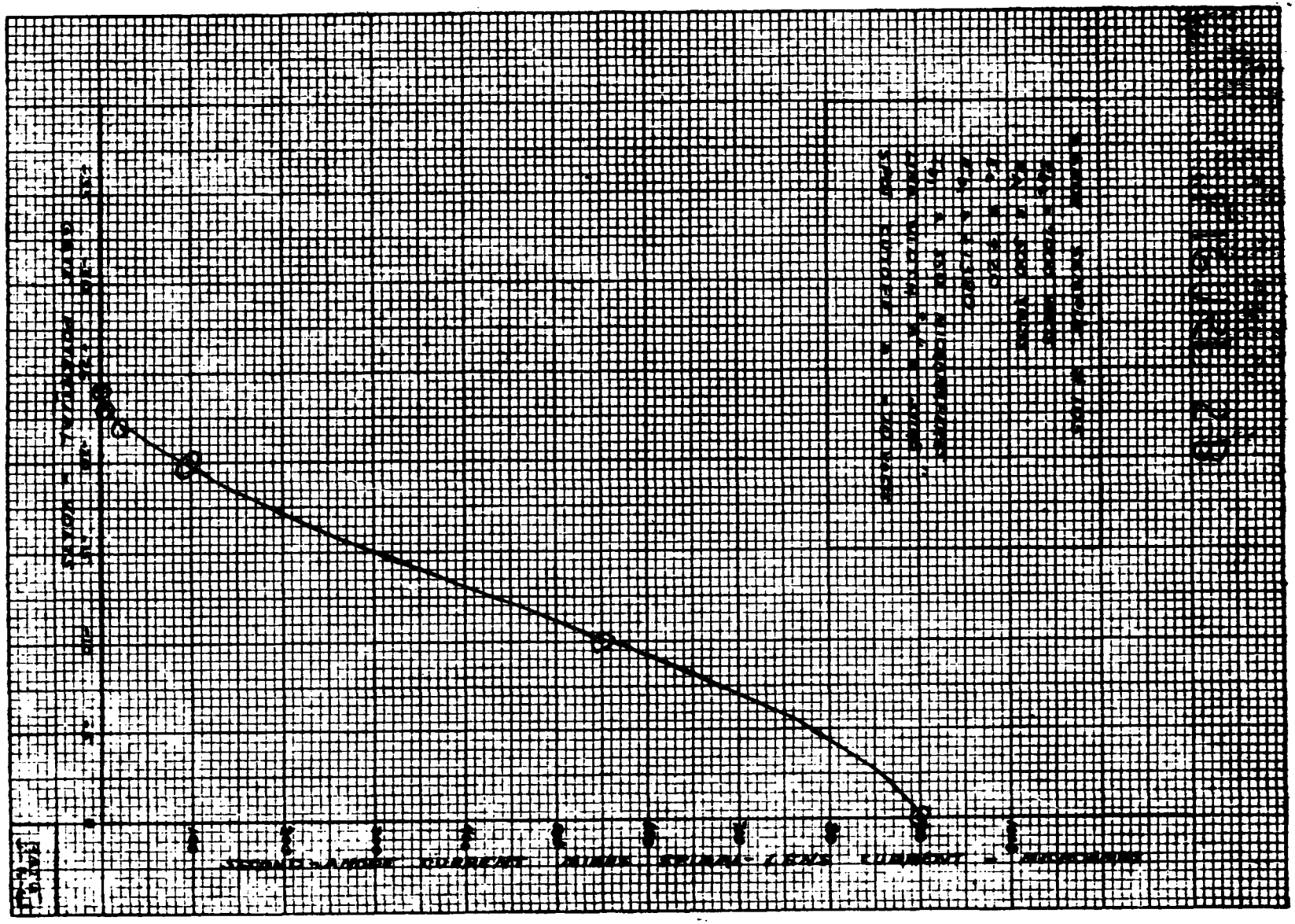


FIGURE 3-A

GENERAL ELECTRIC COMPANY

Focus Reflex Modulation Magnetic Deflection Tube Type 24809

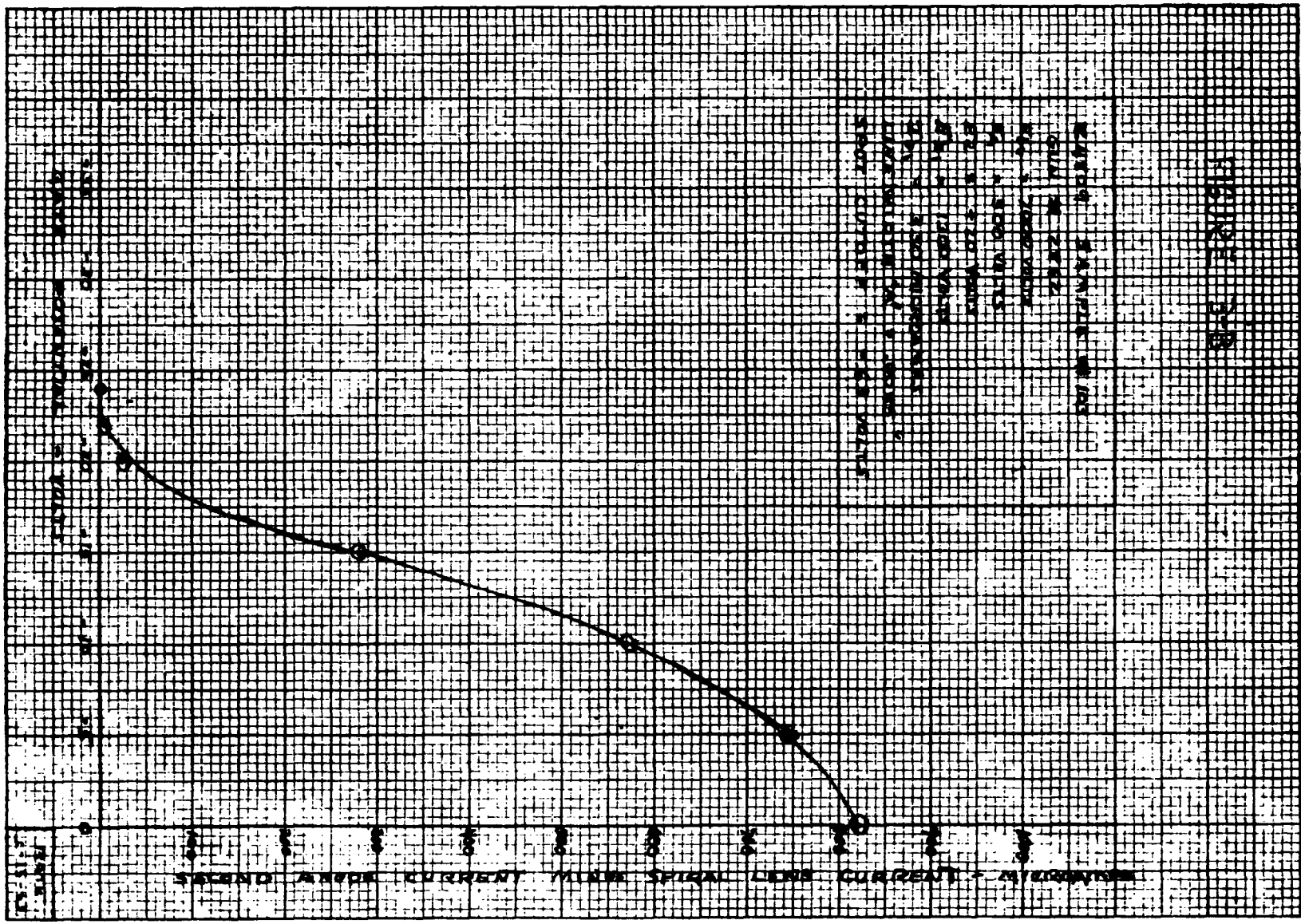
Tested By RATE

Part I: ELECTRICAL TESTS - Per Specification MIL-E-1 Date 19 FEB 67

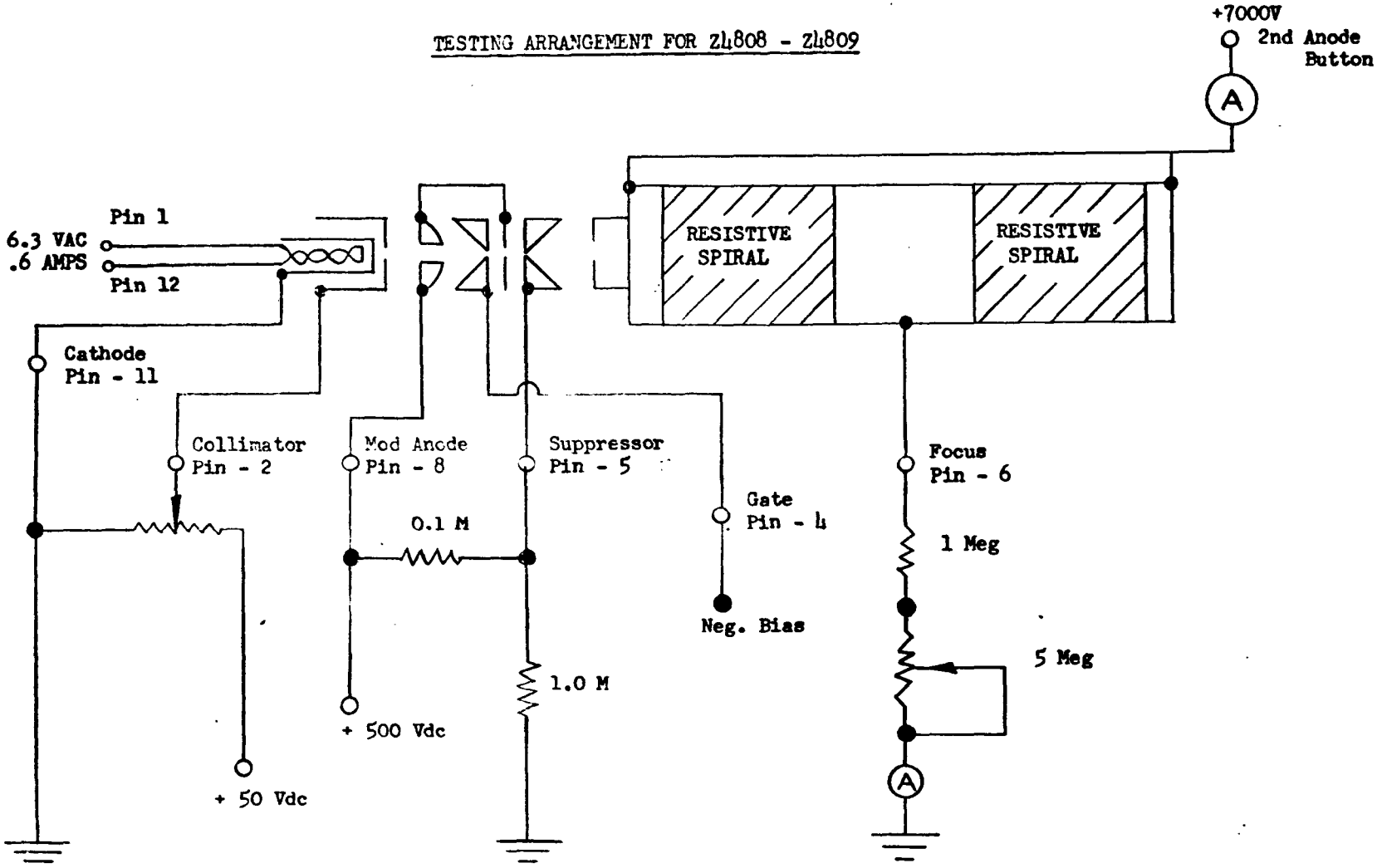
Test Conditions: E_f 6.3 v E_c ADJ E_{b2} 7000 v E_a 500 v E_s 455 v

Breakdown: E_{b2} 10000 v

REF.	TEST	UNITS		Serial No.					
			# 101		# 102		# 103		# 104
4.6.1	Preheating		—		—		—		—
4.10.8	Heater Cur.	Amps	.58		.58		.58		.58
4.12.1.1	Anode #1 Cur	μAdc	310		260		330		300
4.12.1.2	H-K Breakdown		OK		OK		OK		OK
4.12.1.4	Voltage Bkdn.		OK		OK		OK		OK
4.12.2.2	Gas Ratio								
4.12.4.2	Stray Emis. (Std)		NONE		STRAY		NONE		NONE
4.12.5.1	Blemish		OK		OK		OK		OK
4.12.5.3	Modulation Vdc	750μAMP	18.5		23.5		17		19
4.12.5.4	Screen(P-7)	cd5	—		—		—		—
		G5:1	—		—		—		—
4.12.5.4.1	Scr. Brightness	cbf	—		—		—		—
4.12.6.2	Line width A at 100μAdc		.0085"		.0085		.0085		.009
4.12.7.1	Spot position	mm	10		12		8		10
	Zero-bias anode cur:	μAdc	990		740		820		850
	Gate Cutoff (1) I_{b2}=5 amp,	Vdc	-28		-22.5		-22		-26.5
	Gate Raster Cutoff	Vdc	-30		-32		-34		-32
	Gate Spot Cutoff	Vdc	-70		-70		-63		-74
	Focus volt at 100μA:	Vdc	1400		1400		1300		1380
4.12.4.1	Cathode Illumination		OK		OK		OK		OK
4.12.13.1	Heater-cath lkg:	μAdc	0		0		0		0
	Aperture align.	%	—		—		—		—
	Gate leakage:	μAdc	0		0		0		0
	COLLIMATOR :	Vdc	+20		+20		+20		+20


SECOND ANODE CURRENT MINUS SPIRAL COIL CURRENT - MICROAMPERES

TESTING ARRANGEMENT FOR Z4808 - Z4809



IV. PRODUCTION TOOLING

Design and construction work on the production fixtures was begun in this quarter. The required tooling consists of the electron-gun glass-beading fixture, electrode blanking and forming dies, and various positioning fixtures. These tools are designed for incorporation into existing facilities of the Pickup Tube Manufacturing Section in Syracuse. In preparation for the production run, parts are being accumulated; and preliminary processing is being performed.

The construction of the FRM guns is planned to be accomplished in three distinct steps:

1. Fabrication of the glass-beaded electrodes, as one sub-assembly.
2. Construction of the spiral lens, as the second sub-assembly.
3. Final electron-gun assembly, which will involve combining the above two sub-assemblies and adding the stemming, getters, and spring clips.

The use of the spiral Einzel lens is a radical departure from conventional electron-gun construction; but, since the electrical design is self-aligning and insensitive to resistive value deviations, manufacturing problems are not anticipated. The remainder of the tube construction will proceed along conventional lines. The target date for the completion of the preproduction sample group is May 8, 1963. Several tubes will be made prior to this date, however, to determine the suitability of the new tooling.

V. CONCLUSIONS

Several preliminary engineering samples were completed. Four Z4808 and four Z4809 Focus Reflex Modulation tubes are ready for recording of data. These tests will form the basis for the modification of the specification.

VI. PROGRAM FOR NEXT INTERVAL

As a result of the first run of engineering samples, it was determined that the specification would require some modification. This modification will be reviewed and defined during the coming quarter.

VII. PUBLICATIONS AND REPORTS

Monthly Status Report #19 - Edward T. Rate

Monthly Status Report #20 - Edward T. Rate

Monthly Status Report #21 - Edward T. Rate

VIII. PERSONNEL

The Manpower Hours Table on page shows the estimated and actual hours worked during the seventh-quarter period. Laboratory personnel time required to process the experimental tubes is included under the working leader heading. Mr. D. Botsford is performing the production tooling design and construction phase of the program.

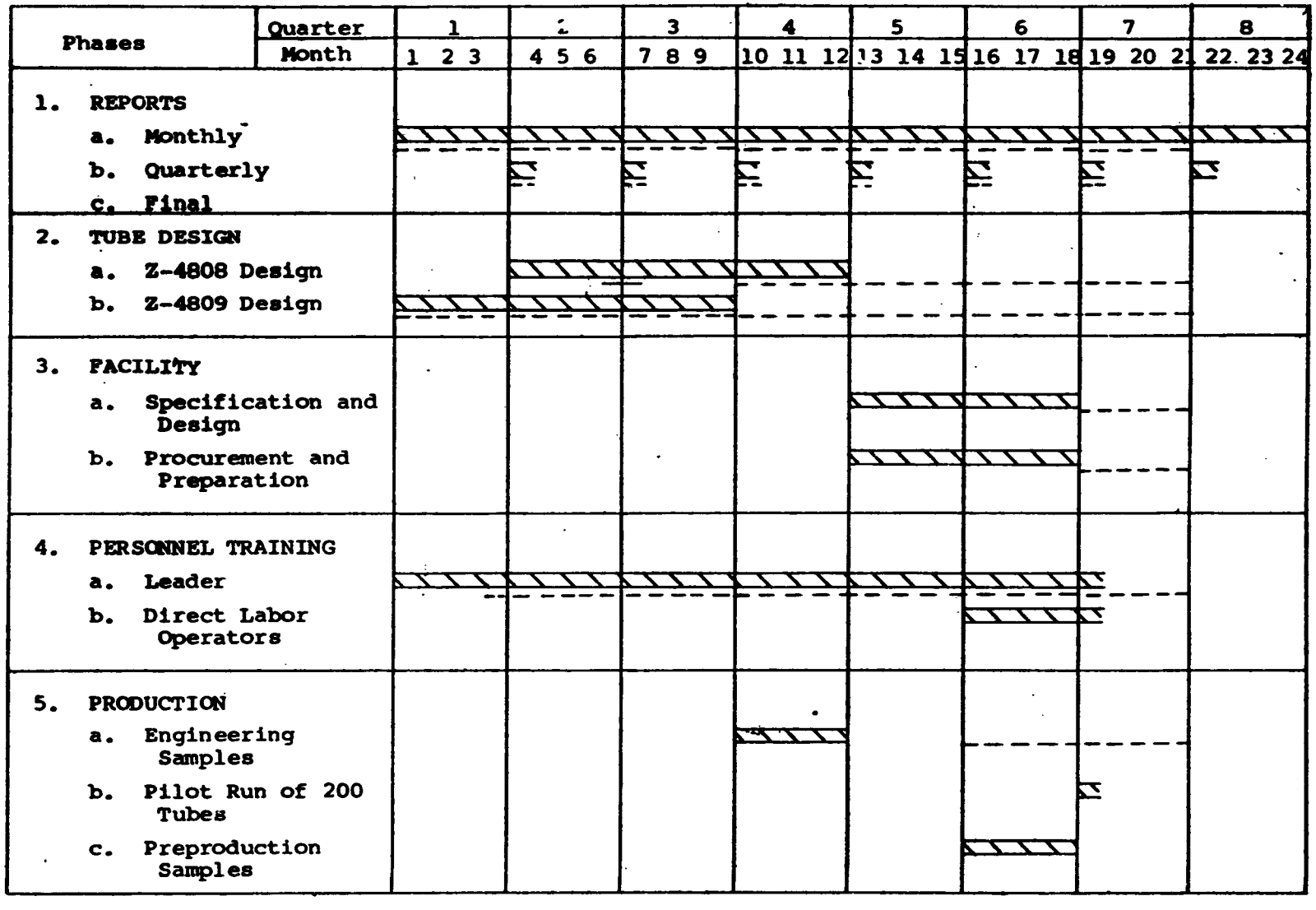
TABLE I

MANPOWER HOURS

ESTIMATED AND ACTUAL

Contributor	Seventh Quarter		Grand Total	
	Estimated	Actual	Estimated	Actual
E. T. Rate	60	105	660	877
Dr. K. Schlesinger and Assistant	0	5	80	164
W. J. Noroski	10	0	170	0
D. Botsford	30	0	210	0
Drafting	20	43	165	96
Working Leader including Laboratory	160	167	670	1095
Machine Shop	0	120	420	556.5
Factory	550	0	600	0
Test Equipment	0	0	240	16
	830	440	3215	2804.5

FOCUS REFLEX MODULATION PROGRESS CHART



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